State of Maryland

BOARD OF NATURAL RESOURCES

Maryland Commercial Fish Hatchery Operations 1944 and 1945

RALPH C. HAMMER

May, 1946

Educational Series, No. 11

Department of Research and Education

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MARYLAND COMMERCIAL FISH HATCHERY OPERATIONS 1944 and 1945

RALPH C. HAMMER

The number and location of commercial fish hatcheries and the methods of their operation in Maryland during the seasons of 1944 and 1945 were the same as reported in the 1942 hatchery report, *Publication No. 54* of the Chesapeake Biological Laboratory. Perch (*Perca flavescens*) were hatched at Severn Run and on the Chester River. Shad (*Alosa sapidissima*) were produced at Denton, Havre de Grace and Millington, and on a cooperative basis at the Belvoir Station of the U. S. Fish and Wildlife Service on the Potomac River.

Continued emphasis was placed during the biennium on increased efficiency of the operations. Further effort was made to determine the true value of Maryland's hatcheries, a problem of major importance in that the shad fishery continues to operate at a low level after almost a century of intensive artificial propagation of the species. Analysis of former yields and trends of the Maryland fishery indicates that increased hatchery activities have failed to prevent continued downward trends of the shad fishery over this long period. Declines in fish populations in other states indicate that hatcheries seldom check depletion in the commercial fisheries and in only rare instances have such activities brought about recovery. As a result of these adverse correlations between hatchery production and rehabilitation, some states have discontinued artificial propagation of commercial fishes. Policies relating to future expansion or even to the continuation of commercial hatchery activities in the State should be based upon demonstrated value or upon experimental tests to determine their possible worth.

Personnel and equipment limitations, brought about by the war, necessitated minor changes in procedures of egg collecting, fry distribution and the study of fingerling growth in ponds during the two year period. The wasteful and destructive practice of permitting hatchery personnel to fish for shad as a method of supplementing the meager supply of shad eggs purchased from the commercial fishermen was discontinued, with the exception of limited experimental fishing at the Chester river station.[1]

[1] Described in detail in Maryland Commercial Fish Hatchery Operations, 1943.

The study of practical methods to rear shad to the size of fingerlings (2-5 inches) was expanded with marked success. However, the use of restored abandoned mill ponds for the rearing of shad was discontinued due to a number of factors, namely: uncontrolled predators, unfavorable emergent vegetation, fluctuating water supply and adverse chemical conditions of the water, which combined to reduce environmental fitness for the purpose.

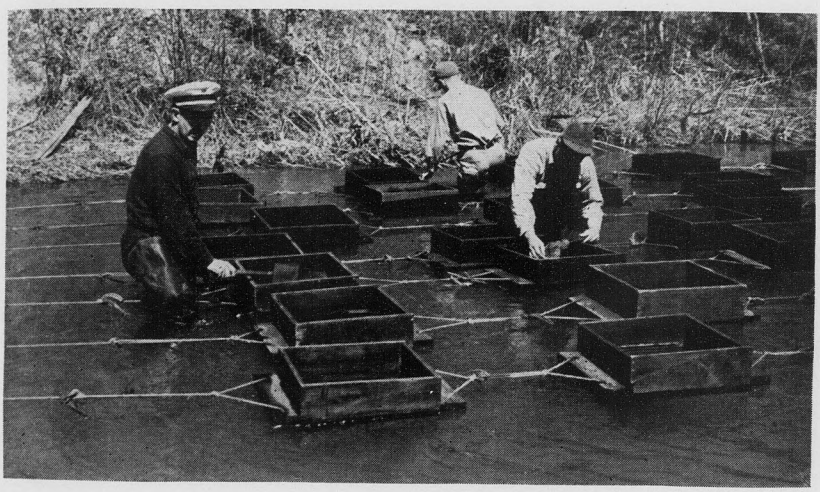
Perch fry produced during the period here reported, were released in the several tidewater streams whose waters were suitable for their survival, while most of the shad fry were released on the spawning grounds from which the adults were captured to provide spawn. Sexually mature pickerel, *Esox reticulatus,* obtained from Susquehanna river commercial fishermen, were released in 1944 in the waters of Lankford Creek in an effort to rehabititate the pickerel fishery in that area.

Yellow Perch

Hatcheries were operated for yellow perch from March through mid-April. Data from observations made during the spawning migration of this fish correlated with statistics of the catch to indicate that the perch population is numerically large in most tidewater streams. The commercially unworked Severn river population has been comprised of a consistently high percentage of large fish, whereas in those streams subject to intensive commercial fishing the average size of random population samples typically falls below the legal limit of seven inches. Whether the abundance of small fish is due to an intensive fishery, a scarcity of food or other factors was not determined. However, there was no evidence of inadequate natural spawning to maintain the present populations, since all streams visited during the spawning season were found to contain vast quantities of viable eggs. Such bountiful spawning was especially marked in the Severn, Choptank and Chester rivers.

The advance migration of male perch to the spawning grounds was found to be well in progress, both in 1944 and 1945, when the hatcheries were opened on March first. A few strings of eggs were observed each year during the first week in March. Cold weather in 1944 delayed further spawning until March 15th, when the spawning peak occurred. An exceptionally warm period during March, 1945, advanced spawning from 8 to 14 days over previous years, at all stations. Maximum spawning occurred during the night of March 9th.

Considerable difficulty in collecting eggs was experienced at Severn Run and to a lesser extent at the other stations during both years, as a result of a change in the location of the spawning beds. Heretofore, spawning has taken place in the more rapid waters of the Run, itself, largely above all tidal effects, whereas during these years the fish choose the more open tidal waters. No reason for this change of spawning



Yellow Perch Incubation Boxes, Severn Run.

grounds was determined. Egg collections were, therefore, made largely by boat and not by the more effective wading operations as in the past. Only a few perch were observed on the spawning grounds formerly used, and very few eggs were collected from these areas. However, the loss of eggs prior to collection was extremely high due to a peculiarity in the spawning. Usually the females, accompanied by several males, seek out submerged weeds, roots, bushes, or other material and deposit their eggs on or around them during the hours of darkness. Typically, the bottom of the more open tidal waters is free of such things, thus the most ideal points for egg deposition were created during periods of high tide, when quantities of shore line vegetation are submerged. It was during high tide and among the temporarily submerged vegetation that the brood fish deposited most of the egg masses. These eggs, in turn, were exposed to drying and even freezing, during the periods of low water, conditions that resulted in excessive mortality. The actual tolerance of perch eggs to temperatures below freezing and

the effects of exposure to drying were not determined. It was found that the eggs subjected to such exposure appeared normal when collected and continued to look normal for 24 hours or longer after collection, by which time they turned white, the usual color of dead eggs. Many of these normal appearing eggs were collected and placed in the incubation boxes at considerable effort in not only the collecting operations, but in the continuous removal of dead eggs. Similar egg mortalities, to a somewhat lesser extent, were observed at the Eastern Shore hatcheries.

The mortality of perch eggs ordinarily is low during the period of incubation, under artificial as well as under natural conditions. This fact accounts for the hatching efficiency typical of the operation. Approximately 80% of the eggs collected during the two years covered here produced hardy fry. Favorable air temperatures prevailed during both seasons, thus mortality of the fry was low in the period of transplantation. Perch fry plantings for 1944 and 1945 are summarized in Tables I and II while the break-down of plantings is indicated in Tables III, IV, V and VI.

TABLE I

COMMERCIAL FISH HATCHERY OPERATIONS—SEASON 1944

QUANTITY OF EGGS COLLECTED AND THE FRY HATCHED FOR VARIOUS SPECIES

Location of Hatchery	YELLOW PERCH (Perca flavescens) Eggs Collected	YELLOW PERCH (Perca flavescens) Fry Hatched	Efficiency %	SHAD (Alosa sapidissima) Eggs Collected	SHAD (Alosa sapidissima) Fry Hatched	Efficiency %
Severn River	111,000,000	77,700,000	70	.....	.....	.....
Chester River	28,000,000	26,000,000	95	1,554,000	932,400	60
Choptank River	37,800,000	37,422,000	99	2,324,00	1,394,400	60
Susquehanna Area (Havre de Grace)	.....	.....	.....	46,536,000	4,653,600	10
Potomac River (U. S. Belvoir Hatchery)	.....	.....	.....	.....	2,737,066	.....
Total	176,800,000	141,122,000		50,414,000	9,717,466	

TABLE II

COMMERCIAL FISH HATCHERY OPERATIONS—SEASON 1945

QUANTITY OF EGGS COLLECTED AND THE FRY HATCHED FOR VARIOUS SPECIES

Location of Hatchery	YELLOW PERCH (Perca flavescens) Eggs Collected	YELLOW PERCH (Perca flavescens) Fry Hatched	Efficiency %	SHAD (Alosa sapidissima) Eggs Collected	SHAD (Alosa sapidissima) Fry Hatched	Efficiency %
Severn River	157,700,000	110,390,000	70	.....	.....	.....
Chester River	38,400,000	32,640,000	85	420,000	336,000	80
Choptank River	40,6000,000	39,788,000	98	1,764,000	1,234,800	70
Susquehanna area (experimental jar system)	.....	.....	.....	980,000	78,400	.....
Potomac River (U. S. Belvoir Hatchery)	.....	.....	.....	.....	3,061,000	.....
Total	235,700,000	182,818,000		3,164,000	4,710,200	

TABLE III

YELLOW PERCH PLANTINGS IN MARYLAND, 1944

WESTERN SHORE

Locality	Number of fry planted
ANNE ARUNDEL COUNTY:	
Magothy River	560,000
Marley Creek	560,000
Furnace Branch Creek	560,000
Stony Creek	560,000
Rock Creek	560,000
South River	560,000
West River	560,000
Patuxent River	560,000
Spa Creek	560,000
Severn Run	79,080,000
BALTIMORE COUNTY:	
Back River	560,000
Bear Creek	560,000
Middle River	560,000
Gunpowder River	560,000
CALVERT COUNTY:	
Lyons Creek	560,000
Hall Creek	560,000
Hunting Creek	560,000
Battle Creek	560,000
St. Leonard Creek	560,000
Mill Creek	560,000
Patuxent River	560,000
CHARLES COUNTY:	
Mattawoman Creek	560,000
Port Tobacco Creek	560,000
Wards Run (Hilltop Fork)	560,000
Mill Run (Burgess Creek)	560,000
Najemoya Creek	560,000
Zekiah Run	560,000
Gilbert Run	560,000
HARFORD COUNTY:	
Conowingo Pool	6,720,000
Swan Creek	560,000
Bush River	560,000
Little Gunpowder Falls	560,000
PRINCE GEORGE'S COUNTY:	
Patuxent River—Western Branch	560,000
Piscataway Creek	560,000
Oxen Creek	560,000
Swanson Creek	560,000
ST. MARY'S COUNTY:	
St. Mary's River	560,000
Breton Bay (MacIntosh Run)	560,000
St. Clement's Bay	560,000
Chaptico Creek	560,000
Herring Creek	560,000
Budds Creek (Wicomico River)	560,000

TABLE IV

YELLOW PERCH PLANTINGS IN MARYLAND, 1944
EASTERN SHORE

Locality	Number of fry planted
CAROLINE COUNTY:	
Marshyhope Creek	784,000
Mill Creek	784,000
Cabin Creek	560,000
Hunting Creek	560,000
Wye River	784,000
Tuckahoe River	784,000
Mason Branch	392,000
Choptank River	2,020,667
CECIL COUNTY:	
Northeast River	1,000,000
Elk River	1,000,000
Bohemia River	1,000,000
Sassafras River	1,000,000
Millington Pond	1,000,000
DORCHESTER COUNTY:	
Marshyhope Creek	784,000
Blackwater River	560,000
Chicamacomico River	560,000
Transquaking River	560,000
Nanticoke River	784,000
Gales Creek	784,000
Choptank River	2,020,667
KENT COUNTY:	
Fairlee Creek	1,000,000
Langford Bay	1,500,000
Grays Inn Creek	500,000
Stillpond Creek	1,000,000
Sassafras River	1,000,000
Chester River	8,000,000
QUEEN ANNE COUNTY:	
Corsica River	784,000
Southeast Creek	784,000
Red Lion Branch	784,000
Wye River—Eastern Branch	1,568,000
Wye River—Western Branch	784,000
Norwich Creek	784,000
Tuckahoe River	784,000
Chester River	8,000,000
Mason Branch	392,000
Island Creek	784,000
SOMERSET COUNTY:	
Wicomico Creek	784,000
Wicomico River	784,000
Rehobeth Creek	784,000
Pocomoke River	784,000
Kings Creek	784,000
Dividing Creek	784,000

Locality	Number of fry planted
TALBOT COUNTY:	
Skipton Creek	784,000
Moores Creek	560,000
Wye River	784,000
Tuckahoe River	784,000
Norwich Creek	784,000
Choptank River	2,020,665
WICOMICO COUNTY:	
Wicomico River	784,000
Wicomico Creek	784,000
Barren Creek	784,000
Tonytank Creek	784,000
Rewastico Creek	784,000
Quantico Creek	784,000
Nanticoke River	784,000
WORCESTER COUNTY:	
Pocomoke River	784,000
Box Iron Creek	784,000
St. Martins Creek	784,000
Trappe Creek	784,000
Dividing Creek	784,000
Wagram Creek	784,000

TABLE V

YELLOW PERCH PLANTINGS IN MARYLAND, 1945

WESTERN SHORE

ANNE ARUNDEL COUNTY:	
Magothy River	600,000
Stony Creek	600,000
Rock Creek	600,000
South River	600,000
Furnace Branch Creek	600,000
West River	600,000
Marley Creek	600,000
Patuxent—Priest Bridge	600,000
Severn River	77,790,000
BALTIMORE COUNTY:	
Back River	600,000
Middle River	600,000
Bear Creek	600,000
Gunpowder Falls	600,000
CALVERT COUNTY:	
Lyons Creek	600,000
Hall Creek	600,000
Hunting Creek	600,000
Battle Creek	600,000
St. Leonard Creek	600,000
Mill Creek	300,000
Helen Creek	300,000
CHARLES COUNTY:	
Mattawoman Creek	600,000
Port Tobacco Creek	600,000
Wards Run	600,000

Locality	Number of fry planted
Mill Run	600,000
Najemoya Creek	600,000
Zekiah Swamp Creek	600,000
Gilbert Swamp Creek	600,000
Wicomico River	400,000
HARFORD COUNTY:	
Conowingo Pool	8,400,000
Swan Creek	600,000
Bush River	600,000
Gunpowder River	600,000
PRINCE GEORGE'S COUNTY:	
Patuxent—Western Branch	600,000
Patuxent—Priests Bridge	600,000
Piscataway Creek	600,000
Oxen Run	600,000
Swanson Creek	600,000
ST. MARY'S COUNTY:	
St. Mary's River	600,000
Breton Bay (McIntosh Run)	600,000
St. Clement's Creek	600,000
Chaptico Creek	600,000
St. George's Creek	600,000
Budds Creek	600,000
Wicomico River	400,000

TABLE VI

YELLOW PERCH PLANTINGS IN MARYLAND, 1945

EASTERN SHORE

CAROLINE COUNTY:	
Marshyhope Creek	600,000
Mill Creek	600,000
Watts Creek	600,000
Chapel Branch	600,000
Hunting Creek	600,000
Tuckahoe River	600,000
Choptank River	5,062,667
CECIL COUNTY:	
Northeast River	600,000
Elk River	600,000
Bohemia River	600,000
Sassafras River	600,000
Millington Pond	600,000
DORCHESTER COUNTY:	
Marshyhope Creek	600,000
Choptank River	5,062,667
Blackwater River	600,000
Chicimacomico River	600,000
Nanticoke River	600,000
Gales Creek	600,000
Transquaking River	600,000
Hunting Creek	600,000

KENT COUNTY:

Fairlee Creek	600,000
Langford Bay	1,200,000
Grays Creek	600,000
Stillpond Creek	600,000
Chester River	13,020,000
Sassafras River	600,000

QUEEN ANNE COUNTY:

Corsica River	600,000
Wye River	600,000
Southeast Creek	600,000
Norwich Creek	600,000
Tuckahoe River	600,000
Chester River	13,020,000

SOMERSET COUNTY:

Kings Creek	600,000
Rehobeth Creek	600,000
Wicomico Creek	300,000
Pocomoke River	1,200,000
Wicomico River	600,000
Dividing Creek	600,000

TALBOT COUNTY:

Skipton Creek	600,000
Moores Creek	600,000
Norwich Creek	600,000
Choptank River	5,062,667
Tuckahoe River	600,000
Wye River	600,000

WICOMICO COUNTY:

Wicomico River	600,000
Wicomico Creek	300,000
Barren Creek	600,000
Tonytank Creek	600,000
Rewastico Creek	600,000
Nanticoke River	600,000
Quantico Creek	600,000

WORCESTER COUNTY:

Pocomoke River	1,200,000
Trappe Creek	600,000
Dividing Creek	600,000
Wagram Creek	600,000

Shad

Hatcheries for the propagation of shad, as already indicated, were located on the Chester, Choptank and Susquehanna rivers during 1944 and 1945. Floating incubation boxes were used at the three shad hatcheries with the exception of an experimental jar system employed in 1945 on the Susquehanna river. Men were assigned to the Fish and Wildlife hatchery on the Potomac river in furtherance of a cooperative plan to provide shad fry for release in the Patuxent river.

The number of adult shad taken on the Potomac, Chester and Choptank rivers in 1944 was above the average of the past few years. A marked increase in the average catch per fisherman, during the same year, in the Susquehanna area, indicated the presence of a greater spawning population than had occurred in that area for at least ten years. The brood stock of 1945 also was high in the Susquehanna area and in the Potomac river. The catch per fishing effort on most Maryland shad spawning grounds continued to increase, with the exception of the Chester River where the take was unusually low in 1945. No marked increase in the Patuxent River population was evident in either 1944 or 1945. It should be noted that the one-time shad-productive Patuxent river was selected in 1940 as a test stream in an effort to evaluate the worth of shad fry stocking. Since then from one million to three million or more fry have been released in it annually. No observable mortality occurred while the fish were in transit. The failure to obtain a noticeable increase of shad in this depleted river in the face of annual stocking appears to indicate either a negligible survival of fry or failure of the resulting adults to return to the stream in which they were planted. Irrespective of survival or the migration behavior of these hatchery produced fish, rehabilitation of the shad run has not been accomplished. These results again bring up the question of the effectiveness of the present hatchery techniques and the part they play in restoration of this resource.

The Chester river station was operated for shad on an experimental basis to supply fry to the rearing ponds under investigation. Two men were employed during 1944, and the station was operated by one man in 1945. Fry in excess of these used in the ponds were liberated in the Choptank river. Only eggs purchased from Choptank and Tuckahoe fishermen were incubated at the Choptank river station. All fry from them were released in the waters from which the eggs were collected. Continued studies were made of hatchery methods and possible sites in the Susquehanna area, in an effort to salvage the vast

quantities of eggs lost as a result of commercial fishing activities in that area. The Potomac river hatchery experienced a better than average season in 1944 and an exceptionally good season in 1945. A portion of the fry from this hatchery was allocated to the Patuxent river and, in addition, the Bear Creek hatchery ponds (Garrett County) were experimentally stocked from this source, as a result of the co-operative support provided by the Department of Research and Education. The quantities of shad eggs collected, fry hatched, and their distribution during 1944 and 1945 are listed numerically in Tables I, II, VII, and VIII.

TABLE VII

SHAD FRY PLANTINGS IN MARYLAND, 1944

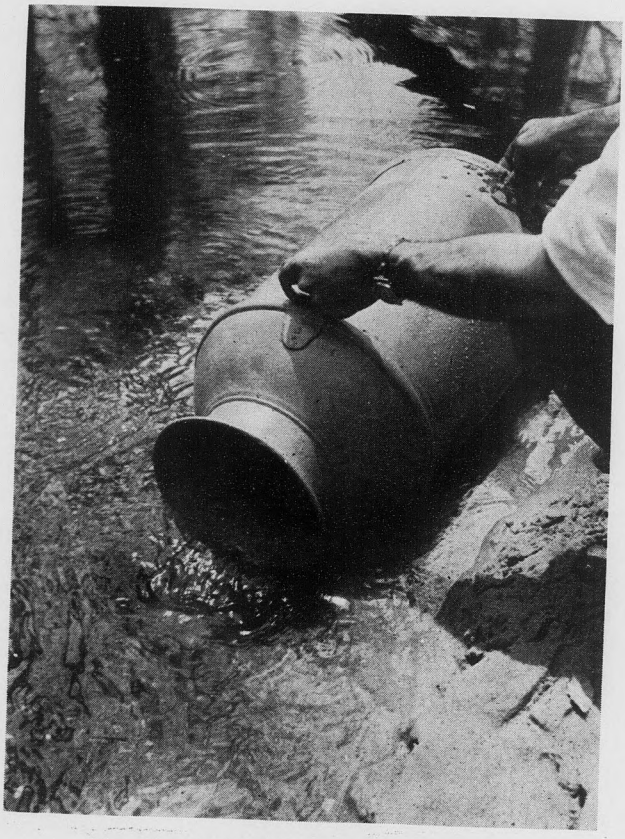
Locality	Number of fry planted
Susquehanna River	4,653,600
Chester River	924,440
Choptank River	894,400
Tuckahoe River	500,000
Patuxent River	2,705,000
Fairlee Pond	7,960
Bear Creek Ponds	13,954
Lost in transit	18,112
Total	9,717,466

TABLE VIII

SHAD FRY PLANTINGS IN MARYLAND, 1945

Locality	Number of fry planted
Chester River	328,000
Choptank River	921,200
Tuckahoe River	392,000
Patuxent River	3,061,000
Fairlee Pond	8,000
Total	4,710,200

Extensive pollution, repeated floods, and destructive wave action have handicapped, if not crippled hatchery work, box system, in the Havre de Grace region where ripe shad in greatest abundance are available as a source of eggs. Experimental tests have disclosed no up-Bay location satisfactory for a hatchery in which eggs could be incubated in floating boxes. However, exceptionally good hatch was



Planting Shad Fry, Choptank River.

experienced in the North East river, near Charlestown, although the lack of protection from storms eliminates this area as a possible year-in and year-out location for the purpose at hand. The waters of the North East river are unpolluted and not too distant from the spawning grounds. The desirability of a hatchery in this area is more fully treated under the topic Discussion.

Due to failure to find a suitable location for the hatching of eggs in boxes, an experimental test was made with water from the city supply at Havre de Grace. A small jar hatchery was secured and installed through the courtesy of the Department of Game and Inland Fish. City water was sprayed into an open tank, four feet in diameter, then siphoned into the hatchery jars. Initial chemical analysis revealed ample oxygen and no detectable chlorine present. Water temperatures ranged from 60 to 65°F. throughout the incubation period. Egg development appeared normal until hatching began, at which time both eggs and fry started to die. Complete loss of all eggs and fry occurred within an hour after the first mortality was observed. Analysis of the water revealed the presence of chlorine that was not removed by aeration. Since it was found that the chlorine can not be entirely or dependably removed by this simple method of aeration, it appears that the cost of equipment and maintenance necessary for the elimination of this toxic material would be greater than pumping water directly from a suitable stream. Samples of eggs placed in the jars were incubated at the Choptank river station where the hatch compared favorably with locally collected eggs.

Pond Rearing: The use of fry for stocking purposes in the commercial fisheries has been found, in most cases, to be ineffective and, as a result, the release of larger fish has gained in favor during recent years. Studies of plantings indicate that a greater return of legal or marketable fish may be expected from the use of fingerling in comparison to the less expensive plantings of fry, which at one time was thought generally to be the answer to fishery restoration. The effort to devise a more productive method of artificial propagation by the rearing of shad to fingerling size was continued in 1944 and again in 1945. Fairlee Pond was used during these years and the success achieved, together with that of the 1943 season, indicates that hardy fingerling shad may be reared with comparative ease in suitable ponds.

During 1944, four small ponds were used for experimental studies of shad rearing at the Bear Creek Trout Rearing Station (Garret County). These ponds, as with Fairlee Pond, were provided through the cooperation of the Department of Game and Inland Fish Commission, and their selection was based upon size uniformity for exact determination of the maximum fingerling production per water surface area. The ponds were filled with water one month prior to the stocking of fry. Commercial fertilizer (Victory Garden 5-8-5) was applied to each pond at the rate of 100 pounds per acre, per application. The initial application of fertilizer was made when the ponds were

flooded, and was continued through the summer as the plankton content showed need until the fingerlings were recovered in the fall. Similar applications of rotted barn manure were made in the Fairlee Pond. The shad fry placed in the ponds in 1944 were counted by hand. Fingerling grown from them were counted when released to determine survival and growth.

The survival of fry in the Bear Creek ponds was exceptionally good, ranging from 41.3% to a high of 95.4%. The reason for this high survival rate in comparison to 29.2% for the Fairlee Pond, during the three years of operation, was not determined. However, the Bear Creek ponds were completely free of predators and they had a well controlled water supply, while the fry placed in them were hatched in jars where fungus infection is reduced to a minimum. Fairlee Pond contained a few mud minnows, water snakes and turtles, and its water supply was difficult to control due to springs and to the activities of muskrats which dug through the diversion ditch to allow continued and at times excessive quantities of water to flow into the pond, greatly diluting the plankton supply as well as the nutrients necessary for food production. The death of fry from fungus when hatched in floating boxes has been found high in cases due to difficulty of removing infected eggs to prevent the spread of disease to live eggs, throughout the period of incubation. Frequently, fry are hatched but due to prior fungus infection, death occurs after the young fish are released from the hatchery. The liberation of infected fry is thought to be the major cause for the poor survival of Fairlee shad. There is listed numerically in Table IX, the experimental shad fry used by ponds, their survival and their growth during 1943, 1944, and 1945.

TABLE IX

SHAD FINGERLING PRODUCTION IN PONDS

Pond Location	Date	Pond Area (Acres)	Fry Stocked	Fingerlings Produced	Survival %	Average Length m. m.
Bear Creek No. 1.....	1944	0.122	1,909	1,821	95.4	46.17
Bear Creek No. 2.....	1944	0.122	2,570	1,825	72.3	40.12
Bear Creek No. 3.....	1944	0.119	3,348	1,670	49.9	55.77
Bear Creek No. 4.....	1944	0.112	3,938	1,626	41.3	34.04
Fairlee	1943	0.283	21,000	673	*	108.15
Fairlee	1944	0.283	7,960	2,323	29.2	68.45
Fairlee	1945	0.283	8,000 **	2,000	25.0	47.00

* Flood waters released an undetermined number of juveniles.
** Estimated fry produced from a known egg volume.

The experience gained and information accumulated from experimental pond rearing, to date, may be summarized as follows: (1) The water supply must be under complete control throughout the period the fish are held in confinement. Additional water should be added only to compensate for losses due to evaporation and to seepage which should be reduced to a minimum. (2) The ponds should remain dry when not in use and should be filled at least one month prior to the introduction of fry. (3) Ponds of one acre or less are best adapted to this type of development. (4) Predators and competitors must be absent or reduced to and kept at a minimum. (5) In order of destructiveness to juvenile shad, are several species of predacious fish, snakes, turtles, birds and aquatic insects. (6) among the competitors for food are plankton feeding fishes and larvae of amphibians and insects. Most of these organisms can be controlled in ponds that are drained annually and allowed to remain dry when not in use. (7) Emergent vegetation, when abundant, prevents adequate aeration, and frequently brings about an oxygen deficiency during the warmer months. Eradication of such plants is necessary. (8) Periodic pond fertilization, to begin at least a month prior to the first fry planting and continued throughout the growing season, is essential for production and maintenance of plankton forage. Most effective quantities for use and the interval between applications have not been determined. (9) Ponds must be so located as to facilitate direct release of the fingerlings into open waters. Juvenile shad can not be netted or transported by the usual methods employed in the recovery of pond fishes due to their delicateness and consequent excessive mortality.

Discussion: It appears that hatcheries work on commercial species should be considered in the nature of supplementary effort toward rehabilitation of the fisheries rather than as taking the place of natural spawning, the greatest single factor in the maintenance of continued high levels of production. Support of hatchery effort to produce fry for planting in already heavily populated streams, with adequate brood stock, as in certain local perch fry uses in the past is unsound, both economically and biologically. There are indications that some Maryland streams have more perch brood reserve than is needed in them, a fact that could well lead to redirection of effort in the hatchery work of the State. Snyder * in a report (1937) to the Conservation Department, stated: "In view of the fact that in many sections yellow perch are extremely abundant, it is recommended that the Department pur-

* Letter from J. P. Snyder, Fish Hatchery Superintendent, U. S. Bureau of Fisheries, May 22, 1937, addressed to Maryland Conservation Department.

chase a part of the catches and transport same as brood stock to other areas that are depleted. It is felt that this type of activities would contribute more toward re-stocking depleted waters at less expense than the present system of collection and hatching spawn to the size to be released." The conditions outlined by Snyder hold, in the main, at this time, although perch populations vary to an extent especially through salt invasions in streams with small drainage areas during years of marked deficiency in precipitation. Also, there are some areas, mostly minor streams, where spawning conditions are not good due to adverse physical or chemical conditions. In such places and in lakes recently created by impoundment, introduced perch thrive and grow.

Extensive perch hatching activities have been carried on successfully for many years. The fry produced have been distributed largely by rote in about every tributary of the Chesapeake Bay regardless of the density of brood stock present and attending success of natural spawning. Observations by the present worker over a three year period indicate the need of a stream-by-stream study of brood abundance and spawning effectiveness in order to establish need, if any, of perch fry plantings. From such observations on three major bodies of water--Severn, Choptank and Chester rivers—it was established that there is no need of fry plantings to increase or even to maintain the population of the waters involved. Actual need of perch fry, it can be indicated, does not necessitate the operation of two or three perch hatcheries in Maryland such as has obtained in the past. The greater part of the demand for repletion can be met by the use of adult fish, caught commercially and, being a hardy type, transported by truck in aerated tanks. The cost would be less. It is recommended that only the Severn Run hatchery be operated henceforth, and that its value be studied in comparison with introduced adult brood fish in those streams where plantings are shown to be needed.

Maryland shad hatcheries for many years have been conducted for the most part on an inefficient basis, due largely to limitations of the floating box unit employed and, in recent years, to inadequate egg supplies. Egg and fry losses occur repeatedly from floods and wind effects which upset the boxes. It is a common experience that when eggs are placed in the boxes for incubation they have a few dead ones among them due to such causes as immaturity and failure to be fertilized in the spawn taking effort. Far more serious are the egg losses from fungus (*Saprolegnia* sp.) infections. Dead eggs offer fine cultural conditions for the disease organism and even when great care is exercised to control and to remove such eggs, the fungus spreads rapidly

to the surrounding living eggs. Much of the bad effect of such infections can not be observed in the hatchery. The fungus is known to continue its development in the liberated fish which, while confined, give no outward indication of infection. Preliminary experiments with certain disinfectants indicate that they are not effective in combating the disease in hatchery boxes under out-of-door conditions. Consideration should be given, therefore, to the jar system of hatching eggs. Through this method, dead eggs readily can be removed, fungus better controlled and, in general, efficiency stepped up.

The two Eastern Shore hatcheries—Denton and Millington—have been of little importance in recent years due to the limited available spawn supply, a development brought about by low fish catches in that area on the part of commercial fishermen as well as hatchery personnel.

Due to the fact that treated water from city sources can not be used successfully in hatchery operations, and because of the known pollution situation in the up-Bay regions tested in connection with development of shad eggs, it is suggested that the fitness of the water of North East River and, possibly, elsewhere in the territory be determined during the 1946 season by means of hatchery boxes and/or through the use of a small unit of the jar system. Chemical analyses of the different areas should be continued. Upon experimental evidence, sound recommendations for a permanent installation could be made. Also, it is suggested that the studies of hatchery efficiency, techniques, pond rearing of fry to fingerling, and the survival of artificially planted fry should be continued and intensified in an attempt to put the hatchery program of Maryland on a substantial constructive basis. One of the greatest needs for the rounding out of the hatchery program is a satisfactory method for the marking of fry and fingerling to determine their survival and growth to capturable sizes. There is little or no evidence from studies to date to indicate that great value has been derived from shad hatchery work in the State. It has been abundantly shown, however, that hatchery practices in recent years, that is, since 1938, have been far from satisfactory; in fact, acceptable neither to the practical man nor to the Department of Research and Education, under whose aegis they have been operated in that period.